EXHIBIT B

SCOPE OF WORK

Approach to Scope of Work (SOW) Tasks

The INTERA Team's technical approach for conducting an evaluation of brackish groundwater in the Gulf Coast Aquifer will result in a high quality product for the Texas Water Development Board (TWDB) that is completed on schedule and within the allotted budget. This section describes our approach to the scope of work tasks, the organizational and management approach we will use to complete the tasks and the reports and other documentation that we will deliver to the TWDB over the course of the project.

Our technical approach to completing the SOW tasks incorporates the following key features:

Gulf Coast Stratigraphy and Lithology – The INTERA Team will use the stratigraphic framework and database developed by Young and others (2010, 2012) to define the formations and aquifers that comprise the Gulf Coast Aquifer. The stratigraphy has been generated based on historical chronostratigraphic log correlations completed by Dr. Tom Ewing and others. As a subcontractor on past INTERA Gulf Coast studies, Mr. Ernie Baker of US Geological Survey (USGS), analyzed more than 1,200 geophysical logs and made over 60,000 picks of lithology on 800 miles of electric log vertical scale. Figure 7-1 in Exhibit A shows the location of the geophysical logs used to characterize the stratigraphy and lithology of the Texas Gulf Coast. The INTERA Team will use the lithology picks made by Mr. Baker as a primary dataset for defining the three-dimensional distribution of sands and clays in the Texas Gulf Coast.

Groundwater Salinity Zones – The INTERA Team will base the identification of fresh, brackish, and saline groundwater using the classification historically developed by the USGS (Winslow and Kister, 1956). As part of his log analysis, Mr. Baker estimated total dissolved solids (TDS) concentrations for each of his 60,000 picks of lithology. All of the TDS picks that Mr. Baker completed will be reexamined using the technical approach developed as part of this TWDB project. The Baker picks used for the project and the associated geophysical logs will be delivered to TWDB as part of the data deliverable. Our technical approach will evaluate TDS using a combination of the following three methods discussed by Estepp (1998): the R_o method, the R_{wa} method, and the R_w method using spontaneous potential (SP). The INTERA Team will document in the draft report which method is used for each TDS interpretation as a deliverable. Our evaluation of the three methods will be conducted using information gathered from geophysical logs that can be paired to nearby wells with known screen intervals that have measured TDS concentrations. To facilitate the evaluation and application of the selected methods, the INTERA Team will digitize at least 300 well logs for analysis. Dr. Scott Hamlin and Mr. Daniel Lupton will lead the development of the technical approach for this task.

Identification of Hydrogeological Barriers – The INTERA Team will map marine and non-marine clay and growth fault zones to identify potentially important hydrogeological barriers.

Dr. Tom Ewing and Dr. Scott Hamlin will map the major clay zones using the same chronostratigraphic approach used by Dr. Ewing in development of the hydrostratigraphy for the Northern Gulf Coast (Young and others, 2012). The grid of regional well-log sections which INTERA previously correlated across the Texas Gulf Coast (Young and others, 2010, 2012) will allow the mapping of both the marine and non-marine thick mud-rich intervals. Dr. Ewing will also evaluate the potential for of growth faults to act as hydrogeological barriers. This work will be an extension of Dr. Ewing's previous mapping of growth faults in the Gulf Coast (Ewing, 1991).

Delineation of Potential Production Areas Separated by Hydrogeologic Barriers – The INTERA Team will map Potential Production Areas using chronostratigraphic analysis of geophysical logs and sand thickness maps to identify transmissive sands associated with: 1) sand-rich fairways with high sand percentage and continuities near marine shale wedges or major fluvial axes, 2) deltaic deposits associated with growth fault trends, and 3) thick fluvial deposits. These sequences will be mapped by re-examining and enhancing the regional well-log sections that INTERA previously correlated across the Texas Gulf Coast (Young and others, 2010, 2012). After the Potential Production Areas have been identified, we will delineate portions of them that are separated by hydrogeologic barriers sufficient to prevent significant impacts associated with pumping on water availability or water quality in any part of the same or other fresh water aquifer.

Assessment of Pumping Impacts – Drs. Neil Deeds and Steve Young will apply groundwater flow models to evaluate the impacts of pumping in Potential Production Areas. To better represent the location of hydrogeologic barriers and brackish zones, a three-dimensional model more vertically refined than the existing Groundwater Availability Model (GAM) may need to be developed to assess these impacts. Multiple model runs will be conducted to evaluate the sensitivity of the predicted pumping impacts to modeling assumptions and a range of aquifer parameters.

Volumes of Brackish Zones – As part of Task 3, Mr. Marius Jigmond will calculate brackish groundwater volumes through development and application of a methodology that is based on TWDB's approach to calculating total estimated recoverable storage and will incorporate the detailed sand, clay, and water quality profiles obtained from the geophysical log analyses. Mr. Jigmond has developed similar codes for previous projects. These calculations and codes will be provided to TWDB as a deliverable.

Geophysical Logs – To help acquire important geophysical logs for the project, the INTERA Team has entered into an agreement with two commercial firms to provide geophysical logs to TWDB for public use. These two firms are DrillingInfo and the Subsurface Library. While logs obtained from commercial companies can sometimes be considered proprietary, INTERA's agreement with these firms ensures that the Gulf Coast Aquifer portion of these logs will be available for public distribution.

Feasibility of Approach

In developing our approach to performing the brackish groundwater evaluation for the Gulf Coast Aquifer, we considered three primary criteria—all of which are indicative of the feasibility of our approach to successfully completing this project.

Scientific Soundness:

- Our approach uses the same sequence stratigraphy techniques for defining hydrogeologic barriers and brackish production areas that have been successfully demonstrated by oil and gas companies for the last 20 years for defining hydrogeologic barriers and transmissive sand units.
- Our approach uses the lithology method utilized by Dr. Baker to evaluate over 1200 electric logs, consisting of approximately 800 vertical scale miles, for TWDB and Groundwater Conservation Districts (GCDs) to begin three-dimensional mapping of sand and clay units.
- We are combining geophysical log and water quality measurement data from wells to generate robust datasets across the Gulf Coast for evaluating approaches to estimate TDS concentration from geophysical logs
- Our approach investigates both empirical and computational approaches to determine the best method to estimate TDS concentrations from geophysical logs, taking into account the wide range of hydrogeological conditions that occur across the Texas Gulf Coast

Capacity to Meet the Required Deadline (within budget and by 30 days after the Project Completion Date):

- We have agreements with two major commercial well log firms – the Subsurface Library and DrillingInfo—to provide redacted geophysical logs for public use that will facilitate quick acquisition of appropriate logs
- Our Team will use PETRA to facilitate and streamline the analysis and management of geophysical logs and we are currently working on a PETRA project for the Gulf Coast project area that has over 1400 logs with picks for lithology and stratigraphy. Logs that are used to delineate the brackish production areas or hydrogeological barriers in the Gulf Coast project will be provided to TWDB as a deliverable.
- We will use scripts to automate the reading of resistivity values for sand beds identified from 500 digital logs that will accelerate estimates of TDS concentrations from geophysical logs. The geophysical logs will be provided to TWDB as a deliverable. Most of the scripts used by INTERA will be embedded PETRA, a commercial software product, or scripts developed as part of previous projects. Scripts that are developed as part of this project will be provided to the TWDB as part of the final deliverable.

As explained above and also confirmed in the following detailed discussion of the scope of work tasks, the INTERA Team's approach is not only technically feasible, but will result in a high quality evaluation of brackish groundwater in the Gulf Coast Aquifer that is completed on-time and on-budget. We are fully committed to delivering the information needed to support the TWDB's report to the legislature on brackish resources in the Gulf Coast by 30 days after the Project Completion Date.

Task 1 – Project Management, Organization and Management

An expedited (less than one year) project on brackish aquifers in the Texas Gulf Coast requires expertise in numerous facets of hydrogeology and well log interpretation. Imperative to the success of the project is a project manager who is intimately familiar with data, models, geology of the Texas Gulf Coast, and the TWDB groundwater program. To satisfy these project requirements, Dr. Steve Young will serve as Project Manager.

Dr. Young will serve as the single point of contact for the TWDB and stakeholders. Dr. Young's project management responsibilities will be to provide prompt and comprehensive information to TWDB and stakeholders regarding the project schedule, budget, and technical considerations. Details of the project organization, management approach, and the anticipated schedule for project tasks and meetings are provided in Section 7.2.

The INTERA Team's proposed project organization is shown in Figure 7-12 in Exhibit A.

Our organization and management approach is designed to satisfy the following objectives:

- provide timely and effective administration of the contract;
- be highly responsive to TWDB;
- ensure efficient access to and optimal use of our personnel as required by each specific technical task;
- provide complete, on-schedule, on-budget, quality-assured performance on all tasks;
- and provide effective communication among Team members and the TWDB and other stakeholders.

Figure 7-13 in Exhibit A shows the primary roles and responsibilities of our management positions. The INTERA Team will monitor project progress using the same procedures that have enabled us to meet scheduled deliverables on other TWDB projects. Monthly status reports, including technical information regarding progress on the project of brackish groundwater in the Gulf Coast Aquifer in the preceding month, will be provided to TWDB. The monthly report will also summarize project progress relative to the schedule. Itemized cost summaries, by task and sub-consultant will be provided to the TWDB with our monthly invoices. These cost summaries will show costs relative to budget. Each project task will be described in detail consistent with the budget description. Project invoices cannot be processed without detailed descriptions of the progress made by tasks.

Monthly project reports will be used as a means of documenting issues, either technical or programmatic, which require consultation with the TWDB. The INTERA Team will report to TWDB Project Manager immediately if an issue occurs. Coordination with TWDB staff will be critical throughout the project. The SOW specifies meetings with the TWDB at various phases of the project. In addition, we anticipate regular communication with the TWDB's Project Manager and other TWDB staff during the project. These additional meetings will be held either in person, through a webinar, or teleconference. INTERA's Austin office, located approximately five miles from the TWDB office, will facilitate communication throughout the project.

At INTERA, project management and control functions are carried out in accordance with a well-established system. Our Project Managers use Axiom's Ajera Complete, a computer-based project control system that integrates time keeping, accounting, and accounts receivable. The Project Manager can monitor project hours and charges in real time since the system updates with every hour added on a time sheet (time is entered on a daily basis). This system provides for detailed tracking of resources and schedules and allows early identification of problem areas so that any required corrective measures can be applied in a timely manner. A key component to our management and control plan is the development of a detailed task plan. As discussed in section 7.1 of our Statement of Qualification, we have divided the Gulf Coast Aquifer project scope of work into seven primary tasks. These tasks are divided into subtasks that further break out the work scope. Our Project Manager will establish the budget for each task, and assign each element of work an appropriate task code designation. The Project Manager will monitor the performance of each work element and will prepare periodic progress reports. These reports will provide various levels of information for each task, as well as for the entire project. This includes personnel hours and direct costs charged to date, current estimates to complete the project, and a comparison of the current estimated total with the previously established budget.

The INTERA Team's proposed project schedule for completing the project of brackish groundwater in the Gulf Coast Aquifer is shown in Figure 7-14 in Exhibit A. In accordance with the schedule requirements defined in the RFP, the project end date is 30 days after the Project Completion Date. The INTERA Team understands that extensions will not be granted.

Table 7-4 provides a breakdown of the percent of effort to be expended for each task along with a labor hour breakdown for each of the INTERA Team companies and consultants.

Task 1a. Monthly Progress Reports

We will submit detailed monthly progress reports to the TWDB outlining progress of the project and include the original or adjusted schedule and detail how the Project is progressing relative to this yardstick. The project report will be described in detail consistent with the budget description.

Task 1b. Senior Technical Review

Dr. Sharp will review technical reports for the approach developed in Task 7, Submit Technical Report.

Task 1 Deliverables:

Detailed monthly progress reports to TWDB consisting of:

- The original or adjusted schedule and relative progress of individual tasks; Project schedule will be updated monthly;
- Project invoices with detailed descriptions of the progress made by tasks;
- Each project task will be described in detail consistent with the budget description;
- Periodic progress in monthly reports that include personnel hours and direct costs charged to date, current estimates to complete the project, and a comparison of the current estimated total with the previously established budget; and
- Any issues that may arise.

Task 2 - Delineate Vertical and Horizontal Extent of Fresh, Brackish, and Saline Groundwater

The INTERA Team will analyze geophysical logs and measured TDS concentrations in wells to delineate fresh, brackish, and saline groundwater both vertically and horizontally in the aquifer. Per the Request for Qualifications (RFQ) requirement, the INTERA Team will categorize groundwater quality according to the classification developed by the USGS (Winslow and Kister, 1956). The USGS classification, based on the concentration of TDS (in milligrams per liter, (mg/L)) in water, is: fresh (0 to 1,000 mg/L); slightly saline (1,000 to 3,000 mg/L); moderately saline (3,000 to 10,000 mg/L); and very saline (10,000 to 35,000 mg/L). The INTERA Team will identify the extent, and quantify the volume of available water in each of these categories. The INTERA Team will not identify zones of TDS concentrations above 35,000 mg/L.

Task 2a. Literature Review of Previous Brackish Groundwater Studies

In preparation for documenting our Team's approach for estimating TDS concentrations from geophysical logs, INTERA will perform a literature review of previous brackish studies relevant to the Texas Gulf Coast Aquifer. The literature review will focus on identifying data and analysis techniques that could potentially benefit this project. The review will cover the following three types of studies:

TDS Concentrations Based on Analyses of Geophysical Logs. These types of studies have been performed by various entities including the TWDB near the City of Corpus Christi (Meyer, 2012), the TWDB at the southern tip of the Gulf Coast (Meyer and others, 2014), by Malcom Pirnie (2001) near the City of Corpus Christi, INTERA (LBG-Guyton and INTERA, 2012) in the vicinity of Montgomery County, and the TWDB for the entire Texas Gulf Coast (Young and others, 2010; 2012).

A review of these and other studies will help identify sources for geophysical logs, locations of Potential Production Areas, and data sets that may be useful to evaluate techniques for estimating TDS concentrations from geophysical logs.

TDS Concentrations Based on Water Quality Samples from Water Wells. There are two notable studies that involve analyses of measured TDS concentrations from water wells in the Texas Gulf Coast. The studies are by LBG-Guyton (2003) and by Young and others (2014). These studies provide actual mapped TDS concentrations that may be useful for estimating and confirming TDS concentrations based on analysis of geophysical logs. Figure 7-2 in Exhibit A shows the spatial distribution of TDS concentrations based on interpolating measured values at 13,500 wells.

Approaches/Techniques for Estimating TDS Concentrations from Geophysical Logs. Possibly the most utilized publication in Texas that describes the methods used for estimating TDS concentrations from geophysical logs in Texas is Estepp (1998, 2010). Estepp (1998) documents the methods used by the Texas Commission of Environmental Quality (TCEQ) to evaluate depth to the base of superior and useable quality water. Another valuable publication is Collier (1993) who performed a project for the TWDB to evaluate the applicability of geophysical logging technology to groundwater-studies.

Task 2b. Assemble and Analyze Geophysical Logs

For geophysical log analysis projects that require expedited schedules such as this project, a potentially important differentiator in choosing a contractor will be their proficiency with PETRA, which is one of INTERA's important qualifications. PETRA is industry-standard software that facilitates acquiring, managing, querying, analyzing, and visualizing geophysical logs. An example of a cross-section of calculated TDS generated by PETRA is shown in Figure 7-3 in Exhibit A. Figures similar to Figure 7-3 in Exhibit A will assist the INTERA Team with evaluating Potential Production Areas.

Both INTERA and the Bureau of Economic Geology (BEG) have existing Gulf Coast geophysical logs in PETRA that could benefit this project. Currently, INTERA has all of the Brackish Resources Aquifer Characterization System (BRACS) logs from the Gulf Coast and logs used by Young and others (2010; 2012) to delineate of the Gulf Coast Aquifer stratigraphy. The BEG has logs associated with investigations of salt domes, Louann salt structures, and growth faults in the Texas Gulf Coast. At the start of the project, BEG and INTERA will combine their PETRA projects into a single PETRA geophysical log project, which will enable the INTERA Team to immediately commence with log analyses. The geophysical logs that come from the combined PETRA project that are used for this project will be provided to TWDB as a deliverable.

The acquisition of available geophysical logs can be a very time consuming process for water resource projects. One reason is that many of the available logs do not provide data coverage at depths shallower than 200 to 300 feet. Another reason is that many logs are of marginal quality because of poor image resolution, missing header information, or missing tools in the suite. In addition, some log source companies do not allow the publication of their logs in the public domain, which is a strict requirement of this project. As a result of numerous previous projects using geophysical logs in the Gulf Coast, the INTERA Team has already identified logs that avoid the first two potential problems of shallow coverage and log quality. To accommodate the project requirement that all logs used as part of the final interpretations or analysis will be available to the public, INTERA has an agreement with INTERA Team members DrillingInfo and the Subsurface Library that ensures the logs will be available for public distribution.

Both DrillingInfo and the Subsurface Library are commercial firms that specialize in selling geophysical logs. The two firms have searchable databases and have access to over two million logs in Texas.

Because of good working relationships with INTERA and a willingness to help Texas find solutions to its water resource problems, both firms have agreed to sell redacted geophysical logs to INTERA that can be freely released to the TWDB and to the public. Letters of agreement for this project are provided in Exhibit A. DrillingInfo states in their commitment letter that, “We believe that offering these logs or portions of the logs that include the aquifers of interest from our private database is an excellent way for us to contribute towards gaining a better understanding of the groundwater resources in Texas”. Subsurface Library states in their commitment letter that “The logs used for this project will be redacted by cutting the log information off at the base of the groundwater aquifer of interest”. As a result of the agreements with DrillingInfo and the Subsurface Library, the INTERA Team will significantly increase the number of available logs available for the project and therefore improve the log coverage in the areas of most interest. The logs will be redacted by only removing information below the depths of interest to this project. One of the reasons for this preference is that we have a verbal commitment from Subsurface Library that it will consider the base of the Catahoula formation as both the depth of interest and the base of the Gulf Coast Aquifer. INTERA will work with the TWDB to establish estimates of the base of the Catahoula formation for the project. The Subsurface Library anticipates that a few logs may need to redacted above the base of the Catahoula, but INTERA will try to minimize the use of logs such logs. TWDB will accept redacted logs, on a case by case basis, if a well was completed within the Gulf Coast Aquifer and that production zone is still considered to be sensitive by the log firms.

Task 2c. Develop Technical Approach for Estimating Sands and TDS from Geophysical Logs

The INTERA Team will evaluate the benefits of two basic approaches for estimating TDS concentration from geophysical logs: 1) computational, and 2) empirical. In computational approaches, the chemical composition of groundwater is calculated from log responses using equations based on both petrophysical principals and empirically derived relationships. In the empirical approach, data derived from groundwater chemical analyses are compared to resistivity values in the same zone, and regression statistics are calculated to estimate TDS from resistivity. The most commonly used computational and empirical methods in Texas are the minimum R_{wa} method and the mean R_o method, respectively. These two methods are described by Estepp (1998, 2010) and are listed in Table 7-1. Computational approaches (e.g. R_{wa} method) require solving a series of equations using variables that characterize the aquifer system. Among the key variables used by the R_{wa} method are porosity, cementation, water chemistry, and lithology. Automation of computational approaches can speed up the analytical process (Meyer and others 2012, 2014). Most computational approaches also require development of a correlation between TDS and specific conductance, which varies with location and formation.

The empirical approach (i.e. mean R_o) involves correlating deep resistivity (long normal or deep induction) with chemical analyses of water samples that are derived from either water wells or oil and gas wells (Fogg and Blanchard, 1986; Collier, 1993; Young and others, 2010, 2012). A log-log graph of TDS versus resistivity is constructed and can be used to define resistivity ranges that correspond to the categories of groundwater salinity: fresh, slightly saline, moderately saline, and very saline. An example graph from an INTERA project in the Gulf Coast aquifer in San Patricio County is shown in Figure 7-4 in Exhibit A.

As shown in Table 7-1, both the R_o and the R_{wa} methods have advantages and disadvantages. The INTERA Team has valuable experience applying both methods in the Texas Gulf Coast. Based on our lessons learned, the most promising approach for using the R_o method is to apply it to selected areas across the Gulf Coast. In such a piecemeal application of the R_o method, there may be different empirical relationships applied to different areas. For instance, the Catahoula Formation in the northern Gulf Coast may have a different empirical relationship between resistivity and TDS than does the Evangeline Aquifer in the southern Gulf Coast. Among the key factors that can affect a relationship between TDS and resistivity are changes in hydrochemical composition of the groundwater, amount of clays in the sand beds, porosity, and cementation. An understanding of how these key factors vary spatially across the project area, which is part of the experience-base of the INTERA Team, is therefore important to developing a proper approach for using R_o method for this project.

Based on our Team's experience in the Gulf Coast, the R_{wa} method would be best applied across the Gulf Coast with an understanding of how the confidence band associated with its predicted TDS changes with location, formations, and depths. One approach for evaluating the different confidence bans is to quantify the range of values for the input parameters (see Table 7-1) that affect the calculated TDS concentration using the R_{wa} method and determine how the range in input parameter values affect the range in the calculated TDS concentrations. This type of uncertainty evaluation will be performed as part of the evaluation of the R_{wa} method.

During the first month of the project, the INTERA Team will assemble data to evaluate the performance of the R_{wa} method, R_o method, and the R_w from SP method. The evaluation will be conducted by pairing measured TDS concentrations in a water well to a vertical interval of a geophysical log that can be reasonably assumed to reflect the properties of the water-bearing deposits intersected by the well screened section or open interval. For a maximum separation distance of 0.5 miles, the number of water well geophysical pairs in Groundwater Management Area (GMA) 14, GMA 15, and GMA 16 are 700, 980, and 500, respectively. The number and location of the pairings that we will evaluate will be determined as part of our technical approach. An anticipated outcome of these pairings is that most of the water wells associated with these pairings will have TDS concentrations less than 3,000 mg/L. To help overcome this issue, the INTERA Team will reach out to oil and gas companies to obtain information from wells that have TDS concentrations greater than 3,000 mg/L. As part of an on-going project with Evergreen Underground Water Conservation District (EUWCD), INTERA has already obtained information from oil and gas companies for 36 wells with TDS concentrations above 3,000 mg/L that are reported to be located in the Gulf Coast Aquifer by the oil & gas operators. For seven of these wells, the oil and gas companies have provided INTERA with copies of the geophysical logs. INTERA will provide TWDB as a deliverable the portion of the EUWCD data that is a part of the final data set used to delineate the hydrological barriers and/or the brackish groundwater.

Once the data pairs have been identified, an analysis will be conducted with appropriate consideration for the factors that are known to affect the relationship between a deep resistivity log and the TDS concentration of groundwater. These factors were discussed previously in this section and are summarized by Estepp (1998, 2010) and Alger (1966). To help identify the potential importance of changes in environmental concentrations, the INTERA Team will track potentially important differences for each data pair such as geologic formation, depositional environment, temperature, hydrogeochemical facies, and porosity.

Figures 7-5 and 7-6 in Exhibit A show how two of these factors, temperature and hydrogeochemical facies, can vary spatially and with depth. In the final report, the INTERA Team will provide the log data used as part of the final evaluation of the relationship between deep resistivity and TDS concentration.

Figure 7-5 in Exhibit A shows a trend of increasing temperature with depth. Temperature is an important consideration, because resistivity of water decreases with increased temperature. Figure 7-6 shows how hydrochemistry and the anionic composition can vary with location and depth. Anionic composition can be important, because different ions impact the conductivity of groundwater differently. As shown in Figure 7-6 in Exhibit A, groundwater in the Gulf Coast Aquifer often consists predominately of bicarbonate anions near the aquifer outcrop. The chloride fraction of anions increases with depth and with distance down dip. This trend is potentially important, because the bicarbonate ion contributes only about 27% as much conductivity as an equal molarity of chloride ion.

Using the data sets of available geophysical logs and measured TDS concentrations, INTERA will develop a technique for estimating TDS concentrations using the R_{wa} method, the R_o method, and/or the R_w using SP method. INTERA will document the technique in a draft technical report, which is discussed in Task 7a. The documentation will include geophysical logs and measured TDS concentrations to illustrate the key points.

Prior to the submission of the draft report, INTERA will have regular communications with the TWDB project manager to exchange information and receive feedback regarding the development and evaluation of geophysical log analysis techniques and will have the Team's Senior Technical Advisor, Dr. Jack Sharp, review the proposed technique. As part of developing the technique, the INTERA Team will use available data to determine if there is a bias in the calculated TDS concentration that can be related to differences in the composition of the sand beds, which can then be correlated to differences in the sands' depositional environment or formation. INTERA's Team will provide publically available data and geophysical logs that are used to determine any biases in calculated TDS concentrations to TWDB as a deliverable. A possible cause for such a bias is differences in the occurrence of amounts and type of clays in the sands. Previous work performed by INTERA (Young and Lupton, 2014) suggest that such a bias may exist as a function of formation type, which could be a surrogate for different amounts of clays in sands.

The occurrence of fine layers of clay in the sand beds may be a factor of importance; therefore, the INTERA Team includes Dr. Carlos Torres-Verdin of the University of Texas at Austin, Petroleum and Geosystems Engineering Department. Dr. Torres-Verdin has recently developed methods to assess the impacts of clay fractions in sand beds on formation resistivity. If the INTERA Team finds sufficient evidence to suggest that the impact of "dirty sands" on calculated TDS values can be identified and quantified, then Dr. Torres-Verdin will investigate the approaches to correct for this bias. In addition, Dr. Torres Verdin has algorithms that may help to facilitate the identification of sand beds on a geophysical log. If these algorithms are used to help guide the sand picks, then a description of these algorithms will be provided in the draft report.

As part of our quality assurance process, the mapping of Potential Production Areas using our picks in the areas of most interest will be checked against the picks used by the Texas Railroad Commission (RRC) to define the base of fresh water and the base of useable quality water. Figure 7-7 in Exhibit A shows a contour surface of the RRC base to fresh water that INTERA created for a GCD client.

The delineation of the vertical and horizontal extent of fresh, brackish, and saline groundwater will be defined by the calculated TDS concentrations for the sand beds. The logs will be analyzed to identify sand beds greater than a threshold minimum thickness. For the TWDB Gulf Coast project logs that are shown in Figure 7-1 in Exhibit A, Mr. Baker used the minimum thickness of 20 feet to identify a sand layer. Based on our experience with defining TDS concentrations and transmissive zones in the Gulf Coast, the 20 foot thickness criteria should be acceptable across most of the Gulf Coast. As part of our proposed technique, we will investigate whether there are areas where a smaller minimum sand thickness is needed.

To facilitate the expedited schedule and the evaluation of alternative technical approaches, at least 200 geophysical logs will be digitized in addition to the existing digitized logs (estimated at 280) that INTERA currently has in its PETRA project files for the Texas Gulf Coast. For the digital logs, we will use scripts to semi- automatically extract calculated resistivity for sand beds based on different assumptions for interpreting the log curves. These assumptions will be documented in the draft report. INTERA will digitize most of the logs during the first month of the project so that they can be used in our development of the technical approach. After they are appropriately redacted, all of these logs will be provided to TWDB as a deliverable. Scripts developed as part of the project will be provided to TWDB as a deliverable.

We will analyze at least 500 geophysical logs to define TDS profiles using the technical approach. The majority of the logs will be from the TWDB stratigraphy project (Young and others, 2010; 2012) and the TDS values will be picked for the sand intervals identified by Mr. Baker. The logs, sand intervals, and any predicted TDS concentrations will be provided to TWDB as a deliverable. The TDS values calculated using the technical approach will be compared to salinity classification assignments made by Mr. Baker, who used the Ro method based on the breakpoints in Table 7-2. We will use these comparisons to determine the reliability of Mr. Baker's assignments for different salinity classifications. Thus, we will consider all of Mr. Baker's groundwater salinity classifications as preliminary, to be re- evaluated using our technical approach. It should be noted that the technical approach includes a very saline classification for TDS concentrations. The very saline classification was not used by Mr. Baker and is for TDS concentrations above 10,000 mg/L but below 35,000 mg/L. As stated previously, the INTERA Team believes that Mr. Baker's application of the 4-class system (shown in Table 7-3) to characterize lithology on geophysical logs is valid and thus it will be used for this Gulf Coast brackish project. However, additional picks of sands and clays may be used as a revised method, pending approval of TWDB.

Task 2d. Identify Transmissive Zones Using Chronostratigraphic Analyses

Independent of the well log analyses for lithology and TDS concentrations, Dr. Tom Ewing will analyze logs to enhance the Gulf Coast chronostratigraphic framework (Young and others, 2010; 2012) to identify potential transmissive brackish areas and hydrogeological barriers (see Task 4a). Dr. Ewing will map in three-dimensions the sands and sandstones that may serve as Potential Production Areas. These include:

- Sand-rich fairways with high sand percents and continuity. Typically these are shoreline trends near marine shale wedges, or major fluvial axes.
- Deltaic deposits with variable but usually high sand content and moderate continuity. These are common at greater depth, in association with growth fault trends.
- Fluvial deposits with low to high sand content, but low sand continuity. These areas can be estimated for percent sand and presence of thick individual sandstones.

In regions where there is a likelihood that these transmissive features exist in the Catahoula Formation, the lowermost stratigraphic unit of the Gulf Coast Aquifer, Dr. Ewing will expand the chronstratigraphic framework to a depth that either defines the base of the Catahoula or where TDS concentrations are greater than 35,000 mg/l.

Task 2e. Data Documentation and Update of BRACS Database Tables

The INTERA Team has experience working with the BRACS Database tables on several projects and with updating the tables in the BRACS Database as part of the development of the High Plains GAM. Results from the geophysical log interpretation for TDS will be submitted to TWDB and will be documented in tables(s) with links to well numbers, log numbers, depths, and names of geological formations in Microsoft Access database format that can be linked to existing BRACS Database tables. All of the geophysical logs used for any interpretations or analysis will be submitted in Tagged Image Format (TIFF) and, if available, Log ASCII Standard (LAS) format.

All Geographical Information Systems (GIS) data used in this project will be thoroughly documented with metadata including source, field descriptions, and units (as applicable) and use BRACS program-naming conventions and map projection parameters. Geologic formation top and bottom raster surfaces, net sand raster maps, salinity classification zone top and bottom raster surfaces, proposed production area top and bottom raster surfaces, well control point files, and project raster snap grid will be submitted to TWDB. All raster surfaces will share the same map Projection and snap grid attributes. The metadata associated with GIS data obtained from Texas Natural Resource Information System (TNRIS) and the TWDB will be updated to document changes that INTERA made to the files. INTERA will also add information on file name, and when and where the file was obtained to the metadata. TWDB must be able to replicate the volumes estimated and techniques used to determine the extent of each of the salinity classification zones.

Task 2 Deliverables:
See Section II and III of the Request for Qualifications NO. 580-16-RFQ0008 for detailed descriptions of deliverables (Exhibit I). See Exhibit D for report formatting guidelines, Exhibit G for data requirements, and Exhibit H for report outline.

- Perform literature review for data and analysis techniques of previous brackish studies relevant to the Texas Gulf Coast Aquifer for: 1) TDS concentrations based on analyses of geophysical logs, 2) TDS concentrations based on water quality samples from water wells, and 3) approaches/techniques for estimating TDS concentrations from geophysical logs.
- Provide appropriate references to information used in the literature review. Provide copies of all water well reports, all water quality reports, and all geophysical well logs used in the project for any interpretations or analysis that were not already in the BRACS database
- Provide copies of redacted logs from DrillingInfo and the Subsurface Library that are used in the final analysis.
- A draft report documenting the technique(s) and approaches for geophysical well log interpretation of aquifer total dissolved solids concentration. TWDB will have up to 10 business days to review the draft report, and the Contractor will schedule a meeting to discuss the techniques. The report shall:
    - Identify types of geophysical well logs available in the area,
    - Describe how the interpreted total dissolved solids concentration from geophysical well log analysis relates to existing aquifer water chemistry as determined by direct measurements
    - Describe how the log correction factors are determined, and

    - Describe how the interpretation techniques will be applied across the entire salinity range within the Gulf Coast Aquifer.
    - Describe the assumptions used for interpreting log curves.
- Files that delineate transmissive zones, calculate resistivity of sand beds, and/or estimate TDS concentrations.
- Any tools and scripts developed as part of this project to delineate transmissive zones, calculate resistivity of sand beds, and/or estimate TDS concentrations.
- Figure showing the project area for the report
- Figure showing the stratigraphy for the final report
- Figure showing the salinity zones for the final report
- Table showing the volumes of different groundwater salinity classes
- Description of the project area for the final report
- Salinity Zone GIS datasets
- Updated BRACS Database

Task 3 – Quantify the Volume of Available Fresh, Brackish, and Saline Groundwater

The INTERA Team is currently developing a GIS-based application to delineate fresh, brackish, and saline groundwater in GMA 13 as a subcontractor to the BEG, who is contracted by the TWDB. We will adapt the GMA 13 application to construct a GIS-based application for this project. Geophysical logs from previous and/or ongoing projects that are being used for this Gulf Coast project will be provided to TWDB as a deliverable as a redacted log. Our GIS application will allow the user to calculate volumes of fresh, brackish, and saline groundwater by aquifer, county, groundwater conservation district, and groundwater management area for the Gulf Coast Aquifer. The GIS-based application will calculate groundwater volumes using a network of grid cells that represent the Gulf Coast Aquifer and the Catahoula Formation. Notable features of the GIS-application include:

- compatible with ESRI ArcGIS Platform;
- incorporates surface rasters developed by Young and others (2010; 2012) to define the areal extent and vertical boundaries of the Beaumont, Lissie, Willis, Upper Goliad, Lower Goliad, Upper Lagarto, Middle Lagarto, and Lower Lagarto, and Oakville formations;
- base of the Catahoula formation will be represented by the top of the Jackson formation defined by Knox and others (2007) or by a surface defined by Dr. Tom Ewing as part of this project.
- provides options for different assumptions and approaches to calculate volume based on either porosity or a drainage volume such as specific yield; and,
- allows the user to calculate groundwater volumes for any group of grid cells. The GIS application workflow will follow this five-step sequence:

  Step 1. Input information from the BRACS Database. The database will contain the porosity values, sand and clay-bed thicknesses, and water quality estimates from the geophysical log analyses.

  Step 2. Add control points. To guide calculation of groundwater volumes in regions where the geophysical data are sparse or complex, the INTERA Team will develop a set of control points for porosity, specific yield, sand thickness, and TDS concentration based on interpretation and extrapolation of geophysical data, drilling logs, measured TDS concentrations at groundwater wells, and published literature.

Step 3. Generate sand thickness and average porosity (or specific yield) by formation for each grid cell. The application will provide scripts to calculate sand thickness and average porosity by formation at each grid cell. The interpolation of the data in the BRACS Database and control points onto grid cells will use options supported by ArcMap.

Step 4. Generate sand thickness for each water quality type by formation. The application will provide scripts to calculate the sand thickness associated with prescribed water quality category (fresh, slightly saline, moderately saline, or saline) by formation at each geophysical log location.

Step 5. Calculate Groundwater Volumes. The user will specify the area of interest by using an existing shape file or a list of grid cells and assumptions regarding drainage porosity and the formations of interest. The GIS application will create an ASCII file containing the tabulated results and will create shape files showing the spatial distribution of fresh, brackish, and saline groundwater volumes.

As part of Task 3, the INTERA Team will assemble and analyze porosity logs in the Gulf Coast, including sonic (acoustic), neutron, and density logs. This task will include Dr. Scott Hamlin. Dr. Hamlin has worked with INTERA on several projects in the Gulf Coast that involved porosity estimates and assisted in mapping sands and correlating logs as part of a TWDB Gulf Coast Stratigraphy Study (Young and others, 2010; 2012). To guide our approach for estimating porosity we will review the Gulf Coast literature (Loucks et al., 1986; Revil, 2002; Revil and Cathles, 2005) and develop relationships that account for changes in porosity with formation, depth of burial, temperature, and type of diagenesis. Porosity logs used to estimate spatial variability of porosity across the Gulf Coast will be provided to TWDB as a deliverable.

Prior to developing the GIS application to calculate groundwater volumes for the project, we will meet with the TWDB to explain the data available for the application, the options available to the user for interpolating the data, and the options available for calculating water volumes. The GIS application deliverable to the TWDB will include raster surfaces for the tops and bottoms of the geologic formation, raster maps of the net sand, raster surfaces and tops and bottoms of the salinity classification zones, raster surfaces of the tops and bottoms of the proposed production areas, well control point files, and project raster snap grids. All raster surfaces will share the same map projection and snap grid attributes. INTERA will provide well documented metadata as described in Task 2e and Task 7c.

Task 3 Deliverables:

- Raster surfaces for the tops, bottoms, and thicknesses of the geologic formation, raster maps of the net sand, raster surfaces and tops and bottoms of the salinity classification zones, raster surfaces of the tops and bottoms of the proposed production areas, well control point files, and project raster snap grids

- GIS files used to create formation surfaces if different from the formation surfaces obtained from the TWDB.
- Detailed description of the methodology used to create each surface if the formation surfaces are differ from the formation surfaces obtained from the TWDB.
- Control points containing porosities, specific yield, sand thicknesses, and TDS concentrations
- Sand thickness data for each water quality category (fresh, slightly saline, moderately saline, and saline) by formation
- Shapefile(s) and/or raster(s) showing distribution of fresh, slightly saline, moderately saline, and saline groundwater volumes
- Detailed volume calculations
- Description of the volumes for the final report
- Description of the salinity zones for the final report
- Description of approach to estimate porosity with description of any relationships that account for changes in porosity with formation, depth of burial, temperature, and type of diagenesis
- Files used to delineate salinity zones and volumes
- Tools and scripts developed as part of this project

Task 4 –Delineate Potential Production Areas

As part of Task 2, the INTERA Team will identify transmissive zones that could possibly serve as Potential Production Areas. In Task 4, we identify the most promising sites where long-term pumping of a brackish transmissive zone would not significantly impact: 1) water quality or quantity of fresh water in the same or adjacent aquifers or 2) a brackish groundwater source currently serving as a significant water supply. To accomplish this task, we will map potential hydrogeological barriers and identify areas to be protected.

Task 4a. Map Hydrogeologic Barriers

The primary goal associated with mapping hydrogeological barriers is to provide geologic constraints on the location and deliverability of brackish groundwater in the Gulf Coast Aquifer and Catahoula Formation. In particular, to identify major shale aquitards /aquicludes that separate resource-bearing sections and to investigate the role of growth faults in separating resource sections. Resources of brackish and saline water occur to great depths in the Gulf Coast Basin in geologic units ranging from Oligocene to Pleistocene in age (see Figure 7-8 in Exhibit A). Some of these units are separated in seaward and down-dip areas by continuous marine shales that act as aquicludes (marked in blue in Figure 7-8 in Exhibit A). Several of these continuous marine shales represent maximum flooding surfaces that are used as chronostratigraphic markers or boundaries by Young and others (2010; 2012).

Through the Gulf Coast, the transmissive sands and sandstones are distributed in a complex fashion. In particular, zones of high sand content, deposited in rivers, deltas and shorelines, are separated from each other by thick masses of mud-rich section deposited in lagoonal and floodplain environments. These non- marine clays (marked in green in Figure 7-8 in Exhibit A), along with the marine clays, can isolate transmissive deposits and form barriers to the flow of brackish water, and thereby limit the thickness and continuity of sections containing reservoir sandstones. Thick non- marine clay sections frequently occur in the Lagarto and upper Catahoula formations, but they are not continuous across the Gulf Coast.

Besides regional and thick clays, major fault trends may serve as hydrogeological barriers for water resources in the Gulf Coast Basin. The regional growth fault trends form during deposition at the shelf-slope break due to slumping, sediment compaction and salt movement. The faults expand and isolate deltaic and shorefront sandstone sections that were deposited near the old shelf margin, frequently leading to development of abnormally high pressures in the sections (simplistically shown on Figure 7-9 in Exhibit A). Some of these faults continue to offset younger, shallower horizons but they are not systematically documented. Specific examples where faults have acted as hydrogeological barriers are discussed in Galloway and others (1977) and Kreitler and others (1977) (see Figure 7-10 in Exhibit A). On regional sections, these fault trends have been approximately mapped by Ewing (1991).

For this subtask, Dr. Ewing will expand and enhance the chronostratigraphy constructed by Young and others (2010; 2012) to map and characterize the marine and non-marine clays that could serve has hydrogeological barriers to groundwater flow. In addition, Dr. Ewing will examine logs and evaluate the potential for growth faults to act as hydrogeological barriers. Geophysical logs used by Dr. Ewing to evaluate hydrogeological barriers will be provided to TWDB as a deliverable.

Task 4b. Identify Protected Areas

The RFQ states three conditions where Potential Production Areas cannot exist. The first condition is where groundwater has an average TDS concentration of more than 1,000 mg/L and is serving as a significant source of water supply for municipal, domestic, or agricultural purposes. To identify these areas, the INTERA Team will review a current listing of groundwater permits from the GCDs in the Gulf Coast, a current listing of public water supply (PWS) wells from the TCEQ, and the large-diameter wells listed in the TWBD database on submitted driller's reports. In addition, we will coordinate with the TWDB to locate any other databases that could help identify any significant water source of interest. Prior to identifying these water supplies, we will meet with the TWDB to clarify the meaning and/or intent of "significant impact."

The second condition identified in the RFQ where Potential Production Areas cannot exist is as part of a geologic stratum that is designated or used for wastewater injection through the use of injection or disposal wells permitted under Texas Water Code Chapter 27. To identify these areas, the INTERA Team will review databases at the RRC and the TCEQ that list the injection and disposal wells that have been permitted.

To meet the third condition specified in the RFQ, we will not identify any Potential Production Areas in the Harris-Galveston Subsidence District and the Fort Bend Subsidence District.

Task 4c. Delineate Potential Production Areas

Based on the findings from Tasks 4a and 4b, the INTERA Team will identify Potential Production Areas. The areas must be brackish/saline, potentially productive, and hydrogeologically isolated from the designated protected areas. Each of the areas will be assigned a unique identification number. Maps will be created showing the location of the areas, prior to meeting with TWDB staff.

Task 4d. Meet with TWDB Staff to Discuss Potential Production Areas

Dr. Steve Young and others will meet with the TWDB Staff to discuss the hydrogeology of Potential Production Areas identified by the INTERA Team and we will work with the TWDB to evaluate the Potential Production Areas and develop a list of these Potential Production Areas that will be modeled over a 30-year and a 50-year production period in Task 6.

Task 4 Deliverables:

See Sections II and III of the Request For Qualifications NO. 580-16-RFQ0008 for detailed descriptions of deliverables (Exhibit I). See Exhibit D for report formatting guidelines, Exhibit G for data requirements, and Exhibit H for report outline.

- Description of areas excluded from consideration as Potential Production Areas for the final report
- GIS datasets delineating areas excluded from consideration as Potential Production Areas
- Figure showing areas excluded from consideration as Potential Production Areas for the final report
- files used to delineate Potential Production Areas
- Tools and scripts developed as part of this project to delineate Potential Production Areas
- Description of any hydrogeologic barriers identified for the final report
- GIS datasets of any hydrogeologic barriers identified for the final report
- Figure showing any hydrogeologic barriers identified for the final report
- Logs used for evaluating the potential for growth faults acting as hydrogeological barriers
- Description of Potential Production Areas identified for the final report
- Potential Production Areas GIS datasets
- Figure showing Potential Production Areas for the final report
- Before the second stakeholder meeting, develop a list of possible impacts to water availability and water quality if the areas were produced
- Meet with TWDB Staff to Discuss Potential Production Areas

Task 5 –Stakeholder Communications

The INTERA Team will coordinate with the TWDB regarding the date, time, and location of the stakeholder meetings. The INTERA Team will be available to attend at least two stakeholder meetings. TWDB will organize the meetings and invite stakeholders including at a minimum all the groundwater conservation districts within the Project area. Based on Sections 2.2(F) and 2.2(P) of the RFQ, we have planned for a general meeting and a final project meeting. The INTERA Team will provide a draft of any presentation to TWDB for review and comment four days before the meeting.

Task 5 Deliverables:

- Stakeholder Meeting 1: Already held on October 26, 2015 in Austin, TX to explain TWDB's approach in implementing House Bill 30, solicit feedback on what constitutes "significant impact", and receive general comments concerning implementation of the legislation;
- TWDB Meeting 1: Project Initiation Meeting;
- TWDB Meeting 2: Discussion and approval of Project methodology; date to be determined by INTERA;
- Stakeholder Meeting 2: Presentation and discussion of Potential Production Areas with stakeholder in the morning; INTERA will set the date and provide a minimum of one-month advance notice to TWDB; TWDB will organize the meeting and invite stakeholders;
- TWDB Meeting 3: Discuss prioritization areas for production calculations with TWDB staff in the afternoon on the same day of the stakeholder meeting; and
- TWDB Meeting 4: Project completion; formal presentation at the end of the Project.

See Section II of the Request For Qualifications NO. 580-16-RFQ0008 for detailed descriptions of meetings (Exhibit I). Additional technical meetings may be scheduled either in person, through a webinar, or teleconference venue to discuss project progress and issues. TWDB staff may periodically visit the Contractor's work premises to assess progress on the project. Any meetings and/or conference calls will be held on regular business days (M-F) during regular business hours (8:00 am- 5:00 pm CT) upon agreed dates and times.

Task 6 – Determine Volume of Brackish Groundwater over 30-year and 50-year Periods

After the stakeholder meeting in TWDB Meeting 3, INTERA will meet with TWDB staff to finalize an approach to estimating the brackish groundwater availability in the identified production areas using stakeholder input. The approach will be designed to be reproducible internally at TWDB. INTERA will provide sufficient data to delineate potential production areas that are separated by hydrogeologic barriers sufficient to prevent significant impacts to water availability or water quality in any part of the same or other fresh water aquifers. INTERA will not be making recommendations to TWDB staff to designate brackish groundwater production zones; only the TWDB Executive Administrator will make these recommendations. The modeled availability will be calculated for 30-year and 50-year production periods, while demonstrating impact to water quality and quantity under the conditions that are described in Task 4b.

Task 6a. Design of Groundwater Model

Subject to approval of an approach in Task 6, a groundwater model will be developed for each of the prioritized Potential Production Areas of interest using a three-step process. The number of prioritized areas that will be modeled will be negotiated with TWDB as part our technical approach in TWDB Meeting 3. The first step is to develop a two- dimensional groundwater model from a vertical dip-oriented cross-section. The model will have a numerical grid that honors the stratigraphic boundaries and is more vertically refined than the existing Groundwater Availability Models for the Texas Gulf Coast (Chowdhury and others, 2004; Kasmarek, 2013; Hutchison and others, 2011). The models' numerical grids will have a non-uniform grid spacing with the most refined numerical mesh occurring in the vicinity of the Potential Production Areas. Figure 7-11 in Exhibit A shows a schematic of the geologic components of the two-dimensional model. This schematic is based on actual stratigraphic surfaces and well data for a cross-section cut through Karnes and Victoria counties. The wells shown in the figure include those that are within five miles of the cross-sectional transect.

The second step in developing the model is to assign aquifer properties to the two-dimensional vertical cross-sectional Modflow-based model. The two-dimensional model will contain: 1) model layers that represent the boundaries of hydraulic barriers, formations, and aquifers; 2) a column of grid cells aligned with dip of the Gulf Coast aquifer that is approximately perpendicular to the coast line; and 3) a row of only one grid cell. The properties will be based on a review of the following: 1) the current GAMs, 2) the conceptual model for the GAM in progress for GMA 15 & 16, 3) the measured values of aquifer properties from reports, and 4) the literature review of relationships between aquifer hydraulic properties and aquifer characteristics such as depth of burial, percent sand, depositional environment, formation, age of sediments, and proximity to shoreline. We will assign properties to the model based on the estimated physical characteristics and lithology of the aquifer. For each aquifer hydraulic property, a best estimate, an upper value, and a lower value will be assigned to each grid cell. An important consideration for assigning properties to grid cells will be the mapped marine and non-marine clays and the transmissive sandstones and sands identified by team member Dr. Tom Ewing. The final report will describe the approach and rationale used for estimating the hydraulic properties.

The third step will be to replicate the two-dimensional model along strike to create a simple three- dimensional model. The two dimensional model will be expanded by increasing the number of grid cells in a row from one to many. The model will be expanded along strike at least 30 miles in both directions. With increasing distance from the original transect, the width (along strike) of the grid cells will increase. The groundwater model methodology selected by the INTERA team will need to address water quantity and quality changes in any part of the same or other fresh water aquifers. No transport modeling will be performed. The groundwater models that will be developed will only be capable of simulating groundwater flow.

Task 6b. Application of Groundwater Model and Calculation of Available Volumes

For prioritized potential production areas, a steady-state pre-development scenario will be used as the initial condition for 30-year and 50-year pumping scenarios. For the pumping scenarios, the INTERA Team will develop a baseline model run that represent our team's estimated aquifer hydraulic properties. From the baseline model, we will perform a series of Monte Carlo-type runs based on at least three different values of pumping and seven different combinations of assumed aquifer parameters. The simulated hydraulic heads for each model run will be processed using in-house scripts that currently exist to calculate pumping impacts. Examples of pumping impacts that can be quantified include average drawdown across a region, drawdown values at a boundary, drawdown at existing wells, or changes to desired future conditions (DFCs). Results from the modeling runs will be processed to document water quality and quantity impacts.

Mr. Sutherland will assist with developing cost estimates for treatment of specific groundwater constituents that can hamper desalination of brackish groundwater for the Potential Production Areas.

Documentation of the baseline model run for each Potential Production Area will be provided in the draft report along with the set of aquifer parameters used for the Monte Carlo simulations.

<u>Task 6 Deliverables:</u>

See Sections II and III of the Request For Qualifications NO. 580-16-RFQ0008 for detailed descriptions of deliverables (Exhibit I). See Exhibit D for report formatting guidelines, Exhibit G for data requirements, and Exhibit H for report outline.

- Model files used to simulate the production from the Potential Production Areas over 30 and 50 year periods, that provide information necessary to determine potential impacts to water quality and quantity, as defined in Task 4
- Provide the necessary model output to determine the volume of brackish groundwater that the Potential Production Areas are capable of producing over a 30-year and 50-year period that provide information necessary to determine potential impacts to water quality and quantity described in item 2.2D of the RFQ
- Description of capacity of Potential Production Areas over 30 and 50 year periods, for the final report
- Table and graph of capacity of Potential Production Areas over 30 and 50 year periods, for different model assumptions and aquifer properties for the final report
- Documentation in the final report of the baseline model run for each Potential Production Areas along with the set of aquifer parameters used for the model simulations
- Cost estimates for treatment of specific groundwater constituents that can hamper desalination of brackish groundwater for the Potential Production Areas

Task 7 – Reporting and Deliverables

Because the studying of brackish groundwater in the Gulf Coast Aquifer will support planners and decision makers in better formulating water management strategies for the resource, thorough documentation of the project data, the methods used to generate the data, and the data analyses results are critical to ensuring it is scientifically defensible. All documentation for the project will be prepared in a manner consistent with the format and content specified by TWDB in Section III – Deliverables of the RFQ (page 7). Reports will include a draft report documenting the techniques and approaches used for geophysical well log interpretation of aquifer TDS concentration, and a final technical report summarizing the results of the project, as described below. A formal presentation on the results of the Project will be made to TWDB at the end of the project.

Task 7a. Draft Techniques and Approaches Report

A draft report documenting the technique(s) and approaches selected by the Contractor for geophysical well log interpretation of aquifer TDS concentration shall be given to TWDB for review at a date determined by the Contractor. The report shall include information on the types of geophysical well logs available in the Project area, how the interpreted TDS concentration from geophysical well log analysis relates to existing aquifer water chemistry as determined by direct measurements (including specific examples), how the log correction factors are determined, and how the interpretation techniques will be applied across the entire salinity range within the aquifer. TWDB will have up to 10 business days to review the draft report, and the Contractor will schedule a meeting to discuss the techniques.

Task 7b. Draft Final Report

We will meet with the TWDB to discuss the schedule for the draft final report; however, we anticipate that the draft report will be delivered by the Project Completion Date and that the TWDB will require 10 working days or less to review and provide comments on the report.

Task 7c. Final Report

The final technical report will summarize the project data, methods, results, and conclusions. The project deliverables listed in the RFQ will be submitted with the final report. The project deliverables will include, but not be limited to, the following:

- A final report summarizing the project with relevant items discussed in Tasks-1-7 will be provided to TWDB.
- Updated data for the BRACS Database containing records of all new geophysical logs used in the Project will be provided to TWDB.
- A list of references to reports used in developing the technical approach will be provided to TWDB.
- Copies of all geophysical well logs used as part of the final project analysis project will

be provided to TWDB (unless those reports and logs already exist in the TWDB Groundwater or BRACS database).

- Copies of water well reports, and water quality reports used in the project will be provided to TWDB (unless those reports and logs already exist in the TWDB Groundwater or BRACS databases).
- All geophysical well logs interpreted for stratigraphic formations, lithologies, TDS and all interpretation data values (input and output) will be documented in tables with links to well numbers, log numbers, depths, and names of geological formations in a Microsoft Access database format that can be linked to existing BRACS Database tables. Geophysical well log data obtained for the Project must be non-confidential and submitted in a Tagged Image Format (TIFF) and, if available, Log ASCII Standard (LAS) format. New well control will be added to the BRACS Database with complete attributes. Water quality data will be compatible with the Groundwater Database table design and should include the source of the data.
- To accommodate the project requirement that all logs used for any interpretations or analysis will be available to the public, INTERA has an agreement with INTERA Team members DrillingInfo and the Subsurface Library that ensures that redacted logs will be available for public distribution.
- To develop new and updated maps of the water resources, the Project should use current information from a variety of non-proprietary databases and geophysical log repositories that are publicly available.
- Three-dimensional GIS datasets that delineate groundwater salinity zones will use ranges of concentrations of TDS of 0 to 1,000 milligrams per liter (fresh), 1,000 to 3,000 milligrams per liter (slightly saline), 3,000 to 10,000 milligrams per liter (moderately saline), and 10,000 to 35,000 milligrams per liter (very saline).
- Three-dimensional GIS datasets that delineate Potential Production Areas and the estimated volumes of brackish groundwater production in 30- and 50-year timeframes will be provided to TWDB. The technique(s) used to determine if a Potential Production Area is hydrogeologically separated from fresh water aquifers shall be thoroughly documented in the technical report. Each Potential Production Area will be assigned a unique ID, and all production area attributes (ID, volume of brackish groundwater subdivided by salinity classification zones, 30-year and 50-year production calculation estimates) will be recorded in a Microsoft Access database table, in supporting GIS files (top, bottom, and lateral extent), and in groundwater modeling files.
- The calculated volumes of groundwater within each aquifer and each TWDB-prioritized Potential Production Area will be organized by salinity classification zone, county, groundwater conservation district, and groundwater management area. All GIS data and files developed by INTERA shall be thoroughly documented with metadata including source, field descriptions, and units (as applicable) and use BRACS program-naming conventions and map Projection parameters. Geologic formation top and bottom raster surfaces, net sand raster maps, salinity classification zone top and bottom raster surfaces, proposed production area top and bottom raster surfaces, well control point files, and Project raster snap grid will be submitted to TWDB. All raster surfaces will share the same map Projection and snap grid attributes.

- TWDB must be able to replicate the volumes estimated and techniques used to determine the extents of each of the salinity classification zones. All Potential Production Area's modeling files will be submitted to TWDB. INTERA will conduct a 4-hour workshop to explain the use of any scripts developed as part of this project and the GIS tools used to calculate volume and determine the extent of the salinity zones.
- TWDB's comments must be addressed in the Final Report and a copy of the comments and the Contractor's response must be incorporated in appendix into the final report. Acceptance of the Final Report indicates the successful completion of the Project.

Derived from Section III of the Request For Qualifications NO. 580-16-RFQ0008 for contract deliverables (Exhibit I). See Exhibit D for report formatting guidelines, Exhibit G for data requirements, and Exhibit H for report outline.

Having produced dozens of draft and final reports associated with our work on other hydrogeological studies and GAM projects for the TWDB, INTERA is intimately familiar with the BRACS and other program contract data requirements, including GIS data and map projection standards, BRACS Database standards, and well report and geophysical well log file naming and organization standards. All draft and final reports will be delivered in both Microsoft Word and PDF formats.